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NASA TECH BRIEF

Langley Research Center

Estimating Sorber Capacity for Multiple Contaminants

The increased importance of contaminant control in manned spacecraft, as crew sizes and mission durations increased, stimulated the development of a design technique to estimate the capacity of carbon (charcoal) for the removal of a large number of contaminants. The technique used to estimate the capacity of a carbon bed considers the bed to be composed of two separate sections, known as the saturated layer (that portion of the bed in which the adsorbate vapor is at an equilibrium concentration) and the adsorption zone (that portion of the bed where equilibrium conditions have not yet been reached). The capacities of the saturated layer and the adsorption zone are estimated by different methods, and the results are combined to find total bed capacity. This approach not only allows the capacity of a sorbent to be estimated, for a wide variety of contaminants, but also includes the interaction effects between the multiple contaminants.

The capacity of activated charcoal for any singly adsorbed material can be calculated from potential theory. This theory relates the equilibrium capacity of the charcoal to a potential parameter, A, which is a function of a specific adsorbate. Tests, conducted with multiple contaminants, have revealed a displacement effect in which materials having a low A value will drive those having a higher A value from adsorption sites. If the difference in A value, ΔA, exceeds some critical value, total displacement is observed. These tests showed that the critical ΔA is 16.

Using these observations, a computer program was generated to estimate the quantity of activated charcoal required to control multiple contaminants. The program scans all contaminants by A value and then orders them from the lowest to the highest values. It calculates the quantity of sorbent required to remove the most strongly adsorbed material; and then, using potential plot data, the capacity of each of the other materials is calculated on the basis of a corrected capacity, which is assumed to be linear with the ΔA value up to the critical ΔA value. The program then proceeds to the next contaminant to be removed and repeats the calculation. This process is continued until all of the contaminants have been absorbed.

In these calculations, experimentally-determined potential plots are used for the sorbents of interest at the anticipated operating conditions. In order to assess the sensitivity of the critical sizing parameters, the ΔA critical, the flow rate, the time, and the contaminant loadings are made inputs to the program. This program has been used to generate various systems designs.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $6.00
(or microfiche $1.45)

Reference: NASA-CR-2027 (N72-26079), Development of a Sorber Trace Contaminant Control System Including Pre- and Post-Sorbers for a Catalytic Oxidizer.

Patent status:

NASA has decided not to apply for a patent.

Source: T. M. Olcott and R. A. Lamparter of
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